PATENT ABSTRACTS OF JAPAN

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(30)Priority

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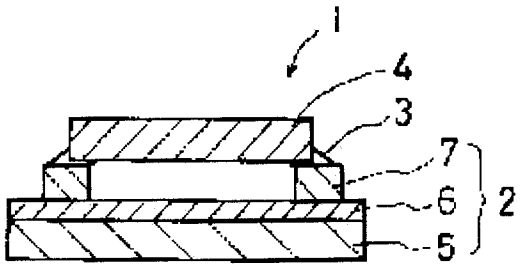
(54) HIGH HEAT DISSIPATION INSULATING SUBSTRATE AND MODULE USING IT

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an extremely useful high heat dissipation insulating substrate in which solder crack resistance is realized while keeping high heat dissipation, and a module using it.

SOLUTION: Related to a metal base substrate provided by laminating an insulating layer on a metal plate, and further putting a conductor circuit on the insulating layer, the insulating layer is a high heat dissipation insulating layer of a heat conductivity not lower than 3.0 W/mK. Further, tensile storage modulus of the insulating layer at 398 K is 1000 MPa or lower.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] a metal plate top -- an insulating layer -- a laminating -- carrying out -- this insulating-layer top -- a conductor -- the high **** insulating substrate characterized by for said insulating layer being a high heat dissipation nature insulating layer which has the thermal conductivity of 3.0 or more W/mK, and moreover the tension storage modulus in 398K of said insulating layer being 1000 or less MPas in the metal base substrate which comes to prepare a circuit.
[Claim 2] The high heat dissipation nature insulating substrate according to claim 1 which the inorganic filler contains 80% of the weight or more in the insulating layer.
[Claim 3] The high heat dissipation nature insulating substrate according to claim 1 or 2 whose insulating layer is thermosetting resin.
[Claim 4] The module characterized by coming to use the high heat dissipation nature insulating substrate of a publication for claim 1 thru/or any 1 term of 3.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] this invention -- a metal plate top -- an insulating layer -- a laminating -- carrying out -- this insulating-layer top -- a conductor -- it is related with the module using the high heat dissipation nature insulating substrate and this which are excellent in a heat dissipation property and pewter-proof crack nature especially about the metal base substrate which comes to prepare a circuit.
[0002]
[Description of the Prior Art] the conductor which installs conventionally the insulating layer which consists of ceramics etc. on metal plates, such as aluminum, as the circuit board which mounts various electronic parts, and consists of conductive foil, such as copper foil, on this insulating layer -- the metal base substrate which comes to prepare a circuit is used.
[0003] In the circuit board, such a metal base substrate is used because to radiate suitably a lot of heat generated from such high febrility electronic parts since many of electronic parts are high febrility is needed.
[0004] Moreover, if it is in the module in the electronic equipment for mount etc., it is necessary to consider as the hollow package structure which does not have resin mold for its miniaturization and space-saving-izing but, the electronic equipment concerned is installed in an engine room in many cases, and with such hollow package structure, since the circuit board will be exposed to the bottom of the severe condition of a direct temperature change, the circuit board which is excellent in a heat dissipation property is needed.
[0005] For this reason, recently, in order to raise further the heat dissipation property of said metal base substrate The high heat dissipation nature insulating layer which made the binder which consists of a resin constituent high-fill up with the inorganic filler (inorganic bulking agent) which has high temperature conductivity as an insulating layer installed on a metal plate is developed. Since it excels also in workability compared with the insulating layer using the conventional ceramics, the metal base substrate of the configuration using current and such a high heat dissipation nature insulating layer is in use.
[0006] in addition, the conductor usually prepared in the metal base substrate concerned through the pewter if it was in such a metal base substrate when various electronic parts were mounted -- a circuit and various electronic parts are joined and fixed.
[0007] However, when the repeat of an intense temperature change is received in an actual operating environment since the difference of this coefficient of thermal expansion becomes remarkably large if the difference of the coefficient of thermal expansion of the metal plate and electronic parts in a metal base substrate is large, and it is when a ceramic chip is used especially as electronic parts, cracks, such as a crack and a deficit, may occur in the pewter part which joins electronic parts and is fixed, or its near.
[0008] Consequently, the conduction path of heat is intercepted, it becomes inadequate radiating heat from electronic parts, the temperature rise and heat deterioration of electronic parts are caused, and the

problem of the property fall of electronic parts, such as a halt of a function and a fall of electric dependability, arises.
[0009] in order to solve this problem -- invention given in JP,2000-151048,A -- a metal plate top -- an insulating layer -- minding -- conductive foil -- laying -- etching -- a conductor -- the metal base circuit board which is a metal base substrate which comes to form a circuit, and provided the technical means with which the product of the Young's modulus in 300K of said insulating layer and coefficient of thermal expansion is characterized by or more 2x102 being 2x106 or less Pa/K is indicated.
[0010] That is, invention given in JP,2000-151048,A is completed based on the knowledge that the metal base circuit board which is excellent in pewter-proof crack nature can be obtained, by attaining low-fever expansion coefficient-ization with low Young's modulus-ization of an insulating layer, and using the resin constituent which controlled the product of Young's modulus and coefficient of thermal expansion especially as a unit insulating layer.
[0011]
[Problem(s) to be Solved by the Invention] By the way, as described above, in order to raise further the heat dissipation property of said metal base substrate recently There are many for which the high heat dissipation nature insulating layer which made the binder which consists of a resin constituent high-fill up with the inorganic bulking agent which has high temperature conductivity as an insulating layer installed on a metal plate is used. If it is when especially thermal conductivity attains the high heat dissipation nature of 3.0 or more W/mK, generally it is that the fill of an inorganic bulking agent is needed in most cases 80% of the weight or more.
[0012] Although can convert this fill (% of the weight) and it cannot be measured with volume % in here since each specific gravity of an inorganic bulking agent differs, generally in addition, generally If it is when an inorganic bulking agent with low thermal conductivity is used more than 65 volume %, if it is when an inorganic bulking agent with high thermal conductivity is used and does not consider as the fill of the inorganic bulking agent more than 80 volume %, it becomes difficult for thermal conductivity to attain the high heat dissipation nature of 3.0 or more W/mK.
[0013] And in the insulating layer made to high-fill up with an inorganic bulking agent in this way, although a coefficient of thermal expansion becomes small according to the effectiveness of an inorganic bulking agent, since an elastic modulus becomes large in inverse proportion to it, the problem that the product of Young's modulus and coefficient of thermal expansion cannot be simply made small occurs.
[0014] For this reason, if it is as a practical question when you make it high-filled up with an inorganic bulking agent in order that thermal conductivity may attain the high heat dissipation nature of 3.0 or more W/mK although said JP,2001-151048,A and [0016] have a publication that 50 in resin constituent - 80 volume % is desirable about the addition of an inorganic bulking agent, it becomes difficult to control the product of Young's modulus and coefficient of thermal expansion.
[0015] Therefore, if it is when being filled up with an inorganic bulking agent, in order that thermal conductivity may attain the high heat dissipation nature of 3.0 or more W/mK in invention given in JP,2001-151048,A, a thermally conductive high inorganic bulking agent is limited and chosen, and de facto limit that the fill of an inorganic bulking agent must be lessened as much as possible arises.
[0016] this invention person used to come to complete this invention at last, as a result of inquiring wholeheartedly and having repeated much prototypes and a trial, in order to solve such a technical technical problem.
[0017] The high heat dissipation nature insulating substrate concerning this invention completed through such circumstances If it is when it is the high heat dissipation nature insulating layer in which an insulating layer has the thermal conductivity of 3.0 or more W/mK in a metal base substrate In view of the ability not to make small simply the product of Young's modulus and coefficient of thermal expansion, by setting the tension storage modulus of the insulating layer of 398K to 1000 or less MPas rather than it It is completed based on knowledge that it can become the very small high heat dissipation nature insulating substrate of the incidence rate of a pewter crack, holding high heat dissipation nature.
[0018] In the metal base substrate which comes to prepare a circuit namely, this invention -- a metal

plate top -- an insulating layer -- a laminating -- carrying out -- this insulating-layer top -- a conductor -- said insulating layer When it is the high heat dissipation nature insulating layer which has the thermal conductivity of 3.0 or more W/mK and the tension storage modulus in 398K of said insulating layer moreover makes it 1000 or less MPas, where high heat dissipation nature is held The purpose of offering the very useful high heat dissipation nature insulating substrate which can realize pewter-proof crack nature is carried out.

[0019]

[Means for Solving the Problem] As described above, a pewter crack percent defective finds out becoming small remarkably by using the resin constituent layer whose this invention is the high heat dissipation nature insulating substrate which used the insulating layer of the high heat dissipation nature which has the thermal conductivity of 3.0 or more W/mK and whose tension storage modulus in 398K is 1000 or less MPas as this insulating layer, and it is completed. Hereafter, this invention is explained to a detail.

[0020] although it is not limited especially if the resin which constitutes an insulating layer is resin excellent in thermal resistance and electric dependability, and well-known synthetic resin can be suitably used in the high heat dissipation nature insulating substrate of this invention -- especially -- the point of thermal resistance or dimensional stability to thermosetting resin -- desirable -- concrete -- for example, an epoxy resin, a CTBN modified epoxy resin, an imide modified epoxy resin, and NBR rubber -- at least one or more sorts of thermosetting resin chosen from a mixture, silicone resin, or urethane resin is desirable.

[0021] moreover, as an inorganic filler used in order to be blended with these resin and to raise the thermal conductivity of an insulating layer It is not what will be limited especially if electric insulation is a good minerals solid-state made from a nonmetal. Specifically For example, at least one or more sorts chosen from an oxide, carbide, a metaled nitride, or a metaled carbonate etc. can be chosen suitably, and can be used, and, as for the configuration, it is desirable independent or to use together and to use a thing [being spherical (granular)] from Men of restoration nature.

[0022] In addition, especially as said metal, although the metal chosen from B, aluminum, Be, V, Fe, Y, Co, Cu, nickel, Si, Sn, Ti, Cr, Ce, Zr, calcium, Ta, Nb, etc. can be mentioned if it says by the symbol of element, specifically [although not restricted] Especially from a viewpoint of being come to hand cheaply [the thing in which high restoration by the spherical particle is possible (closest packing)], and easily by the alumina which is the oxide of aluminum especially, it is desirable and the boron nitride which is the nitride of boron has an especially desirable dielectric constant in a low point.

[0023] And the insulating layer in the high heat dissipation nature insulating substrate of this invention blends said inorganic bulking agent with said resin, and makes the thermal conductivity of an insulating layer come to improve so that it may become the thermal conductivity of 3.0 or more W/mK.

[0024] Here, although it should be suitably chosen by the fill of the inorganic bulking agent in the case of making the thermal conductivity of an insulating layer into 3.0 or more W/mK according to each thermal conductivity of a constituent since it changes with the thermal conductivity which the resin used and an inorganic bulking agent have, generally it is desirable to make the fill of an inorganic bulking agent into 80% of the weight or more of the whole insulating layer.

[0025] It is because it may become difficult to make the thermal conductivity of an insulating layer into 3.0 or more W/mK, so it is not desirable as this reason when a thermally conductive low inorganic bulking agent is used if the fill of an inorganic bulking agent is made into less than 80% of the weight of the whole insulating layer.

[0026] Moreover, as this insulating layer thickness, especially if a desired heat dissipation property is satisfied, it is not limited, but if it is generally when 10 micrometers - 500 micrometers are desirable and it uses as the circuit board for hollow modules further in consideration of productivity, a heat dissipation property, etc., in consideration of the heat leakage nature under the environment on actual use, 10 micrometers - 250 micrometers are more desirable.

[0027] And although it has the biggest description at the point which this invention chooses said inorganic bulking agent as said resin suitably, blends it with it, makes the thermal conductivity of a final

insulating layer 3.0 or more W/mK, and moreover sets the tension storage modulus in 398K of said insulating layer to 1000 or less MPas As a means to measure the thermal conductivity of said insulating layer, it can measure using well-known thermal conductivity measuring apparatus etc., for example, and, on the other hand, can measure as a means to measure the tension storage modulus of said insulating layer, using a well-known dynamic viscoelasticity measuring instrument etc., for example.
[0028] In this invention, it is the value which the rate of thermal conductivity produced the 2.0mm thickness xphi50mm insulating layer (block) with said resin constituent, and was measured using thermal conductivity measuring apparatus (TCA[by the HOROME trick company] 200 LT-A), and the tension storage modulus in 398K is the value which measured the insulating layer using the dynamic viscoelasticity measuring instrument (DMS6100 by the SEIKO electronic industry company) under 10Hz of test frequencies, and programming-rate the conditions for /of 1 degree C.
[0029] the high heat dissipation nature insulating substrate of this invention -- said insulating-layer top -- a conductor -- the thing which comes to prepare a circuit -- it is -- the conductor concerned -- as a metallic foil which constitutes a circuit Although it is not limited especially if it is the metal which has good electrical conductivity, generally It is desirable to use the alloy which consists of two or more sorts which can use suitably copper, aluminum, nickel, iron, gold, silver, tin, a bismuth, molybdenum, or titanium, and were chosen from these metals.
[0030] In this invention, although not limited especially as thickness of said metallic foil, when performing pattern NINGU by etching, it is desirable to consider as the range of 8-300 micrometers. In addition, since electric resistance becomes it high that the thickness of a metallic foil is less than 8 micrometers and a necessary electrical property is not acquired, it is not desirable.
[0031] Moreover, although the good well-known metallic material of heat dissipation nature can be chosen suitably and can be used as a metal substrate used for the high heat dissipation nature insulating-layer substrate of this invention, generally aluminum, iron, copper, and these alloys can be used.
[0032] In this invention, although it is not limited as thickness of said metal substrate especially if a desired heat dissipation property is satisfied, generally it is desirable to consider as the thickness of 0.5mm - about 5.0mm in consideration of productivity, a heat dissipation property, etc.
[0033] in addition, the high heat dissipation nature insulating substrate of this invention -- setting -- an insulating-layer top -- a conductor -- as an approach of preparing a circuit The well-known approach can be used suitably conventionally. Specifically The insulating material which filled up said resin with said inorganic bulking agent for example, on said metal substrate and/or said metallic foil After there being nothing much more and carrying out two or more layer laminating, an insulating material is stiffened by heat-treatment etc. means, such as etching, -- using -- a conductor -- after forming the circuit or making said metal substrate and metallic foil rival through the sheet which consists of an insulating material beforehand -- means, such as etching, -- using -- a conductor -- the approach of forming a circuit etc. is employable.
[0034] By the way, in this invention, the thickness of said metallic foil exceeds 300 micrometers, and when a conductor with difficult etching is required, what pierced in the shape of a pattern and was processed may be pasted up using the resin of this invention.
[0035] The module concerning this invention is formed using the high heat dissipation nature insulating substrate of said this invention, and when the repeat of an intense temperature change is received, even if it is, as a result of being able to prevent that cracks, such as a crack and a deficit, occur in the pewter part which joins electronic parts and is fixed, or its near, it turns into a high module with remarkable electric dependability.
[0036]
[Embodiment of the Invention] Although the example of the high heat dissipation nature insulating substrate which whose purpose and configuration of this invention are as above, and starts subsequently to this invention is explained in full detail, this invention is not limited to this example.
[0037] 80 micrometers of NBR content epoxy resins which contain the spherical alumina as an insulating material 90% of the weight were applied to copper foil with an example 1 thickness of 70 micrometers, and heat adhesion was further carried out with the aluminum plate with a thickness of

2.0mm. This adhesion was performed under the condition of adhesive pressure force 5.9MPa for the temperature of 180 degrees C, and adhesion time amount 2 hours.
[0038] next, a predetermined conductor -- the high heat dissipation nature insulating substrate of this invention was obtained by forming a circuit (chip resistor pad) in a copper foil part by etching.
[0039] The insulating layer of an example 1 was obtained by carrying out etching removal of copper foil and the aluminum plate, respectively from the high heat dissipation nature insulating substrate produced as mentioned above.
[0040] In the insulating layer in this example 1, that thermal conductivity was 3.9 W/mK, and the tension storage moduli in 398K were 350MPa(s).
[0041] The high heat dissipation nature insulating substrate of this invention was obtained like the example 1 except having used the imide modified epoxy resin which contains an un-spherical alumina 86% of the weight as example 2 insulating material.
[0042] Moreover, the insulating layer of an example 2 was obtained like the example 1. In the insulating layer in this example 2, that thermal conductivity was 3.2 W/mK, and the tension storage moduli in 398K were 655MPa(s).
[0043] The insulating substrate concerning the example of a comparison was obtained like the example 1 except having used the bisphenol A mold epoxy resin which contains an un-spherical alumina 86% of the weight as an example insulating material of a comparison.
[0044] Moreover, the insulating layer of the example of a comparison was obtained like the example 1. In the insulating layer in this example of a comparison, that thermal conductivity was 3.5 W/mK, and the tension storage moduli in 398K were 7000MPa(s).
[0045] In addition, the tension storage modulus in 398K was measured using the dynamic viscoelasticity measuring instrument (DMS6100 by the SEIKO electronic industry company) under 10Hz of test frequencies, and programming-rate the conditions for /of 1 degree C.
[0046] Moreover, the rate of thermal conductivity is the value which produced the abbreviation 2.0mm thickness xphi50mm insulating layer (block) with said resin constituent, and was measured using thermal conductivity measuring apparatus (TCA[by the HOROME trick company] 200 LT-A).
[0047] Next, on the metallic circuit plate which prepared the chip resistor mounting pad in the high heat dissipation nature insulating substrate of an example 1 and an example 2, and the insulating substrate of the example of a comparison, the Pb-Sn eutectic pewter was used, it mounted ten chip resistors (chip size 5.0mmx2.5mm, 3.2mmx2.5mm, and 2.1mmx2.5mm) at a time, respectively, and the chip resistor mounting substrate using the insulating substrate of an example 1-2 and the example of a comparison was created, respectively.
[0048] Hereafter, the structure of each of said chip resistor mounting substrate is explained in more detail based on drawing 1 . Drawing 1 is the type section Fig. of the chip resistor mounting substrate 1 formed using the insulating substrate of the aforementioned example 1-2 or the example of a comparison. This chip resistor mounting substrate 1 It consists of said each insulating substrate 2 and a chip resistor 4 joined and fixed by minding the soldered joint section 3 on each of this insulating substrate 2, and said each insulating substrate 2 makes an insulating layer 6 intervene on the aluminum plate 5, and consists of a laminating and a pasted-up metallic foil (conductor circuit) 7. Therefore, in this case, on the metallic foil (conductor circuit) 7 in said each insulating substrate 2, said chip resistor 4 minds the soldered joint section 3, and is being joined and fixed.
[0049] The heat shock trial of the count of predetermined was performed for said each chip resistor mounting substrate under the gaseous-phase conditions for 1 cycle - 40 degree-Cx30 minutes - +125-degree-Cx 30 minutes, and the existence of the crack of a soldered joint part was observed with the microscope. The result is shown in Table 1.
[0050]
[Table 1]

	398Kにおける引張り貯蔵弾性率(MPa)	熱伝導率(W/mK)	ヒートショック試験後のハンダ接合部の観察結果	
			100サイクル	500サイクル
実施例1	350	3.9	異常なし	異常なし
実施例2	655	3.2	異常なし	異常なし
比較例	7000	3.5	部分的なクラックあり	全点においてクラックあり

[0051] In addition, the product of the Young's modulus and the coefficient of thermal expansion in 300K in the high heat dissipation nature insulating substrate of an example 1-2 and the insulating substrate of the example of a comparison to add In the example 1, it is 2.4x106 Pa/K, and is 2.8x105 Pa/K in the example 2. If it is when it is 2.3x105 Pa/K and thermal conductivity uses the insulating layer of 3.0 or more W/mK by this in the example of a comparison Even if it controlled the product of Young's modulus and a coefficient of thermal expansion to 2x102 or more Pa/K [2x106 or less], it was checked from the result with Table 1 that there are not pewter-proof crack nature and functionality.

[0052]

[Effect of the Invention] In the metal base substrate which comes to prepare a circuit this invention -- setting -- a metal plate top -- an insulating layer -- a laminating -- carrying out -- this insulating-layer top -- a conductor -- said insulating layer When it is the high heat dissipation nature insulating layer which has the thermal conductivity of 3.0 or more W/mK and the tension storage modulus in 398K of said insulating layer is moreover constituted by 1000 or less MPas When a substrate with the high-reliability which pewter crack nature cannot generate easily under the remarkable conditions of a temperature change can be obtained, it can become the substrate of high heat dissipation nature.

[0053] namely, a metal plate top -- an insulating layer -- a laminating -- carrying out -- this insulating-layer top -- a conductor -- in the metal base substrate which comes to prepare a circuit, it is the high heat dissipation nature insulating layer in which said insulating layer has the thermal conductivity of 3.0 or more W/mK, and the incidence rate of a pewter crack discovers effectiveness, such as becoming very small, holding high heat dissipation nature by moreover setting the tension storage modulus in 398K of said insulating layer to 1000 or less MPas.

[0054] Moreover, in the high heat dissipation nature insulating substrate concerning this invention, in a metal base substrate, if it is when it is the high heat dissipation nature insulating layer in which an insulating layer has the thermal conductivity of 3.0 or more W/mK, the effectiveness that the problem that the product of Young's modulus and coefficient of thermal expansion cannot be simply made small is also suitably solvable etc. also does so.

[0055] Furthermore, even if the module of this invention receives the repeat of an intense temperature change coming [the high heat dissipation nature insulating substrate of said this invention] to use, it can prevent that cracks, such as a crack and a deficit, occur to the pewter part which is joining and fixing electronic parts, or its near, consequently discovers effectiveness, like electric dependability becomes remarkably high.

[Translation done.]

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TECHNICAL FIELD

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[0003] In the circuit board, such a metal base substrate is used because to radiate suitably a lot of heat generated from such high febrility electronic parts since many of electronic parts are high febrility is needed.
[0004] Moreover, if it is in the module in the electronic equipment for mount etc., it is necessary to consider as the hollow package structure which does not have resin mold for its miniaturization and space-saving-izing but, the electronic equipment concerned is installed in an engine room in many cases, and with such hollow package structure, since the circuit board will be exposed to the bottom of the severe condition of a direct temperature change, the circuit board which is excellent in a heat dissipation property is needed.
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[0006] in addition, the conductor usually prepared in the metal base substrate concerned through the pewter if it was in such a metal base substrate when various electronic parts were mounted -- a circuit and various electronic parts are joined and fixed.
[0007] However, when the repeat of an intense temperature change is received in an actual operating environment since the difference of this coefficient of thermal expansion becomes remarkably large if the difference of the coefficient of thermal expansion of the metal plate and electronic parts in a metal base substrate is large, and it is when a ceramic chip is used especially as electronic parts, cracks, such as a crack and a deficit, may occur in the pewter part which joins electronic parts and is fixed, or its near.
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[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing 1 is the type section Fig. showing the chip resistor mounting substrate formed using the insulating substrate of each example or the example of a comparison.
[Description of Notations]
1 Chip Resistor Mounting Substrate
2 Insulating Substrate
3 Soldered Joint Section
4 Chip Resistor
5 Aluminum Plate
6 Insulating Layer
7 Metallic Foil (Conductor Circuit)

[Translation done.]

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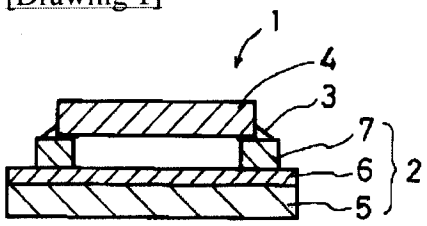
DRAWINGS

[Drawing 1]



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(72)発明者　三屋　昭治
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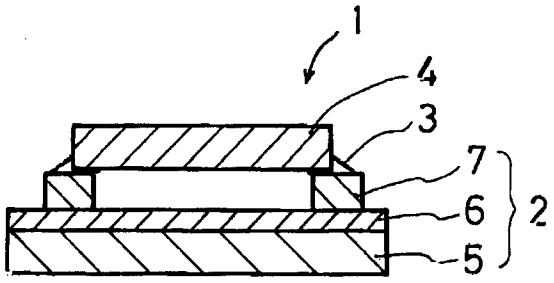
弁理士　澤　喜代治

最終頁に続く

(54)【発明の名称】　高放熱性絶縁基板及びこれを用いたモジュール

(57)【要約】
【目的】　本発明は、高放熱性を保持したまま、耐ハンダクラック性を実現することができる極めて有用な高放熱性絶縁基板及びこれを用いたモジュールを提供することを目的する。
【構成】　本発明は、金属板上に絶縁層を積層し、該絶縁層上に導体回路を設けてなる金属ベース基板において、前記絶縁層は、３．０Ｗ／ｍＫ以上の熱伝導率を有する高放熱性絶縁層であり、しかも前記絶縁層の３９８Ｋにおける引張り貯蔵弾性率が１０００ＭＰａ以下であるを特徴とする。



【特許請求の範囲】
【請求項１】　金属板上に絶縁層を積層し、該絶縁層上に導体回路を設けてなる金属ベース基板において、前記絶縁層は、３．０Ｗ／ｍＫ以上の熱伝導率を有する高放熱性絶縁層であり、しかも前記絶縁層の３９８Ｋにおける引張り貯蔵弾性率が１０００ＭＰａ以下であることを特徴とする高放性絶縁基板。
【請求項２】　絶縁層中に無機充填材が８０重量％以上含有されている請求項１に記載の高放熱性絶縁基板。
【請求項３】　絶縁層が熱硬化性樹脂である請求項１又は２に記載の高放熱性絶縁基板。
【請求項４】　請求項１ないし３のいずれか１項に記載の高放熱性絶縁基板を用いてなることを特徴とするモジュール。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は金属板上に絶縁層を積層し、該絶縁層上に導体回路を設けてなる金属ベース基板に関し、特に、放熱特性及び耐ハンダクラック性に優れる高放熱性絶縁基板及びこれを用いたモジュールに関する。
【０００２】
【従来の技術】従来、各種電子部品を実装する回路基板としては、アルミニウムなどの金属板上にセラミックス等からなる絶縁層を設置し、該絶縁層上に銅箔等の導体箔からなる導体回路を設けてなる金属ベース基板が用いられている。
【０００３】回路基板において、このような金属ベース基板が用いられているのは、電子部品の多くが高発熱性であることから、このような高発熱性電子部品から発生する多量の熱を好適に放散することが必要とされるからである。
【０００４】又、車載用の電子機器におけるモジュール等にあっては、その小型化・省スペース化のために、樹脂モールドのない中空パッケージ構造とする必要があるが、当該電子機器はエンジンルーム内に設置されることが多く、このような中空パッケージ構造では、回路基板が直接温度変化の厳しい条件下に暴露されることになるため、放熱特性に優れる回路基板が必要とされるのである。
【０００５】このため、最近では、前記金属ベース基板の放熱特性を一層向上させるために、金属板上に設置する絶縁層として、高熱伝導性を有する無機フィラー（無機充填剤）を樹脂組成物からなるバインダーに高充填させた高放熱性絶縁層が開発されており、従来のセラミックスを用いた絶縁層と比べて加工性にも優れていることから、現在、このような高放熱性絶縁層を用いた構成の金属ベース基板が主流となっている。
【０００６】なお、このような金属ベース基板において、各種電子部品を実装する場合にあっては、通常ハンダを介して当該金属ベース基板に設けた導体回路と各種電子部品が接合、固定される。
【０００７】しかしながら、金属ベース基板における金属板と電子部品との熱膨張率の差は大きく、特に電子部品としてセラミックチップ部品を用いた場合などにあっては、この熱膨張率の差が著しく大きくなるため、実際の使用環境において、激しい温度変化の繰り返しを受けた際に、電子部品を接合、固定しているハンダ部分やその近傍に亀裂や欠損等のクラックが発生することがある。
【０００８】その結果、熱の伝導経路が遮断され、電子部品からの放熱が不十分となり、電子部品の温度上昇や熱劣化を招き、機能の停止や電気的信頼性の低下等の電子部品の特性低下といった問題が生ずるのである。
【０００９】この問題を解決するため、特開平２０００－１５１０４８号に記載の発明には、金属板上に絶縁層を介して導体箔を載置し、エッチングにより導体回路を形成してなる金属ベース基板であって、前記絶縁層の３００Ｋにおけるヤング率と熱膨張率の積が2×10^{2}以上2×10^{6}Ｐａ／Ｋ以下であることを特徴とする技術的手段を講じた金属ベース回路基板が開示されている。
【００１０】即ち、特開平２０００－１５１０４８号に記載の発明は、絶縁層の低ヤング率化と共に低熱膨張率化を達成し、特に、ヤング率と熱膨張率の積をコントロールした樹脂組成物を単位絶縁層として用いることにより、耐ハンダクラック性に優れる金属ベース回路基板を得ることができるという知見に基づき完成されたものである。
【００１１】
【発明が解決しようとする課題】ところで、前記した如く最近では、前記金属ベース基板の放熱特性を一層向上させるために、金属板上に設置する絶縁層として、高熱伝導性を有する無機充填剤を樹脂組成物からなるバインダーに高充填させた高放熱性絶縁層が用いられているものが多く、特に熱伝導率が３．０Ｗ／ｍＫ以上の高放熱性を達成する場合にあっては、一般に、無機充填剤の充填量は８０重量％以上必要となる場合がほとんどである。
【００１２】なお、ここにおいて、無機充填剤の個々の比重が異なるため、一概に、この充填量（重量％）を体積％に換算して比較することはできないが、一般的には、熱伝導率の高い無機充填剤を用いた場合にあっては６５体積％以上、熱伝導率の低い無機充填剤を用いた場合にあっては８０体積％以上の無機充填剤の充填量としなければ、熱伝導率が３．０Ｗ／ｍＫ以上の高放熱性を達成することは困難となる。
【００１３】そして、このように無機充填剤を高充填させた絶縁層においては、無機充填剤の効果により熱膨張係数は小さくなるが、それに反比例して弾性率が大きくなってしまうため、単純にはヤング率と熱膨張率の積を

小さくすることができないといった問題が発生する。

【００１４】このため、前記特開平２００１－１５１０４８号公報、［００１６］には、無機充填剤の添加量について樹脂組成物中５０～８０体積%が好ましいとの記載があるにもかかわらず、実際問題として、熱伝導率が３．０W／mK以上の高放熱性を達成するために、無機充填剤を高充填させた場合にあっては、ヤング率と熱膨張率の積をコントロールすることが困難となるのである。

【００１５】従って、特開平２００１－１５１０４８号公報に記載の発明において、熱伝導率が３．０W／mK以上の高放熱性を達成するために無機充填剤を充填する場合にあっては、熱伝導性の高い無機充填剤を限定して選択し、できるだけ無機充填剤の充填量を少なくしなければならないといった事実上の制限が生じるのである。

【００１６】本発明者はこのような技術的課題を解決するため、鋭意検討し、数々の試作、試験を繰り返してきた結果、ついに本発明を完成するに至ったものである。

【００１７】このような経緯を経て完成された本発明に係る高放熱性絶縁基板は、金属ベース基板において、絶縁層が３．０W／mK以上の熱伝導率を有する高放熱性絶縁層である場合にあっては、単純にはヤング率と熱膨張率の積を小さくすることができないことに鑑み、それよりも３９８Kでの絶縁層の引張り貯蔵弾性率を１０００MPa以下にすることにより、高放熱性を保持しながら、ハンダクラックの発生率の極めて小さい高放熱性絶縁基板になり得るとの知見に基づき完成されたものである。

【００１８】即ち、本発明は、金属板上に絶縁層を積層し、該絶縁層上に導体回路を設けてなる金属ベース基板において、前記絶縁層は、３．０W／mK以上の熱伝導率を有する高放熱性絶縁層であり、しかも前記絶縁層の３９８Kにおける引張り貯蔵弾性率が１０００MPa以下にすることにより、高放熱性を保持した状態で、耐ハンダクラック性を実現することができる極めて有用な高放熱性絶縁基板を提供することを目的する。

【００１９】

【課題を解決するための手段】前記したように、本発明は、３．０W／mK以上の熱伝導率を有する高放熱性の絶縁層を用いた高放熱性絶縁基板であり、又、この絶縁層として、３９８Kにおける引張り貯蔵弾性率が１０００MPa以下である樹脂組成物層を用いることで著しくハンダクラック不良率が小さくなることを見い出し完成されたものである。以下、本発明を詳細に説明する。

【００２０】本発明の高放熱性絶縁基板において、絶縁層を構成する樹脂は、耐熱性，電気信頼性に優れた樹脂であれば特に限定されるものではなく、公知の合成樹脂を適宜用いることができるが、特に、耐熱性や寸法安定性の点から熱硬化性樹脂が好ましく、具体的には、例えばエポキシ樹脂、ＣＴＢＮ変性エポキシ樹脂，イミド変性エポキシ樹脂，ＮＢＲゴム混合体，シリコーン樹脂又はウレタン樹脂等から選ばれた少なくとも１種以上の熱硬化性樹脂が好ましい。

【００２１】又、これらの樹脂に配合されて絶縁層の熱伝導性を向上させるために用いられる無機充填材としては、電気絶縁性が良好な非金属製の無機質固体であれば特に限定されるものではなく、具体的には、例えば金属の酸化物、炭化物、窒化物又は炭酸塩等から選ばれた少なくとも１種以上を適宜選択して用いることができるのであり、又、その形状は充填性の面から球状（粒状）のものを単独もしくは併用して用いることが好ましい。

【００２２】なお、前記金属としては、特に制限されるものではないが、具体的には、例えば元素記号でいえば、Ｂ、Ａｌ、Ｂｅ、Ｖ、Ｆｅ、Ｙ、Ｃｏ、Ｃｕ、Ｎｉ、Ｓｉ、Ｓｎ、Ｔｉ、Ｃｒ、Ｃｅ、Ｚｒ、Ｃａ、Ｔａ及びＮｂ等から選ばれた金属を挙げることができるが、中でもアルミニウムの酸化物であるアルミナは球状の粒子で高充填可能（最密充填）なものが、安価かつ容易に入手できるなどの観点から特に好ましく、又、ホウ素の窒化物である窒化ホウ素は誘電率が低い点において、特に好ましい。

【００２３】そして、本発明の高放熱性絶縁基板における絶縁層は、３．０W／mK以上の熱伝導率となるよう、前記樹脂に前記無機充填剤を配合し、絶縁層の熱伝導性を向上させてなるものである。

【００２４】ここで、絶縁層の熱伝導率を３．０W／mK以上とする場合の無機充填剤の充填量は、用いられる樹脂や無機充填剤の有する熱伝導性によって変わるため、構成成分の個々の熱伝導性に応じて適宜選択されるべきものであるが、一般には、無機充填剤の充填量を絶縁層全体の８０重量%以上にすることが好ましい。

【００２５】この理由としては、無機充填剤の充填量を絶縁層全体の８０重量%未満にすると、熱伝導性の低い無機充填剤を用いた場合において、絶縁層の熱伝導率を３．０W／mK以上とすることが困難となる場合があるため好ましくないからである。

【００２６】また、この絶縁層の厚さとしては、所望の放熱特性を満足するものであれば特に限定されるものではないが、一般的には、生産性や放熱特性等を考慮して、１０μm～５００μmが好ましく、更に、中空モジュール用回路基板として用いる場合にあっては、実際の使用上の環境下での熱放散性を考慮して１０μm～２５０μmがより好ましい。

【００２７】そして、本発明は、前記樹脂に前記無機充填剤を適宜選択して配合し、最終的な絶縁層の熱伝導率を３．０W／mK以上とし、しかも前記絶縁層の３９８Kにおける引張り貯蔵弾性率を１０００MPa以下とする点、に最も大きな特徴を有するのであるが、前記絶縁層の熱伝導率を測定する手段としては、例えば、公知の熱伝導率測定装置等を用いて測定することができ、一

方、前記絶縁層の引張り貯蔵弾性率を測定する手段としては、例えば、公知の動的粘弾性測定器等を用いて測定することができる。

【００２８】本発明において、熱伝導性率は、前記樹脂組成物で２．０ｍｍ厚×φ５０ｍｍの絶縁層（ブロック）を作製し、熱伝導率測定装置（ホロメトリック社製　ＴＣＡ　２００ＬＴ－Ａ）を用いて測定した値であり、又、３９８Ｋにおける引張り貯蔵弾性率は、動的粘弾性測定器（セイコー電子工業社製　ＤＭＳ６１００）を用い、絶縁層を測定周波数１０Ｈｚ，昇温速度１℃／分の条件下で測定した値である。

【００２９】本発明の高放熱性絶縁基板は、前記絶縁層上に導体回路を設けてなるものであり、当該導体回路を構成する金属箔としては、良好な電気伝導性を有する金属であれば特に限定されるものではないが、一般的には、銅、アルミニウム、ニッケル、鉄、金、銀、錫、ビスマス、モリブデン又はチタニウム等を好適に用いることができるのであり、又、これらの金属から選択された２種以上からなる合金等を用いることが好ましい。

【００３０】本発明において、前記金属箔の厚さとしては特に限定されるものではないが、エッチングにてパターンニングを行う場合には８～３００μｍの範囲とするのが好ましい。尚、金属箔の厚さが８μｍ未満であると電気抵抗が高くなって所要の電気特性が得られないので好ましくない。

【００３１】又、本発明の高放熱性絶縁層基板に用いられる金属基板としては、放熱性の良好な公知の金属材料を適宜選択して用いることができるが、一般的には、アルミニウム、鉄、銅およびこれらの合金を用いることができる。

【００３２】本発明において、前記金属基板の厚さとしては、所望の放熱特性を満足するものであれば特に限定されるものではないが、一般的には、生産性や放熱特性等を考慮して、０．５ｍｍ～５．０ｍｍ程度の厚さとするのが好ましい。

【００３３】なお、本発明の高放熱性絶縁基板において、絶縁層上に導体回路を設ける方法としては、従来公知の方法を好適に用いることができるのであり、具体的には、例えば前記樹脂に前記無機充填剤を充填した絶縁材料を、前記金属基板及び／又は前記金属箔の上に、一層ないし複数層積層した後、加熱処理等により絶縁材料を硬化させ、エッチング等の手段を用いて導体回路を形成したり、或いは予め絶縁材料からなるシートを介して前記金属基板と金属箔を張り合わせた後に、エッチング等の手段を用いて導体回路を形成する方法等を採用することができる。

【００３４】ところで、本発明において、前記金属箔の厚さが３００μｍを超え、エッチングが困難な導体が必要な場合にはパターン状に打ち抜き加工したものを本発明の樹脂を用いて接着させても良いのである。

【００３５】本発明に係るモジュールは、前記本発明の高放熱性絶縁基板を用いて形成したものであり、激しい温度変化の繰り返しを受けた場合にあっても、電子部品を接合、固定しているハンダ部分やその近傍に亀裂や欠損等のクラックが発生することを防止することができる結果、電気的信頼性の著しく高いモジュールとなるのである。

【００３６】

【発明の実施の形態】本発明の目的及び構成は以上の通りであり、次いで本発明に係る高放熱性絶縁基板の実施例について詳述するが、本発明はこの実施例に限定されるものではない。

【００３７】実施例１

厚さ７０μｍの銅箔に、絶縁材料としての球状のアルミナを９０重量％含有するＮＢＲ含有エポキシ樹脂を８０μｍ塗布し、更に、厚さ２．０ｍｍのアルミ板と熱接着した。この接着は温度１８０℃、接着時間２時間、接着圧力５．９ＭＰａの条件下行われた。

【００３８】次に、所定の導体回路（チップ抵抗パッド）をエッチングにより銅箔部分に形成することにより、本発明の高放熱性絶縁基板を得た。

【００３９】前述のように作製した高放熱性絶縁基板から銅箔，アルミ板をそれぞれエッチング除去することにより、実施例１の絶縁層を得た。

【００４０】この実施例１における絶縁層において、その熱伝導率は３．９Ｗ／ｍＫであり、又、３９８Ｋにおける引張り貯蔵弾性率は３５０ＭＰａであった。

【００４１】実施例２

絶縁材料として非球状アルミナを８６重量％含有するイミド変性エポキシ樹脂を用いた以外は、実施例１と同様にして、本発明の高放熱性絶縁基板を得た。

【００４２】又、実施例１と同様にして実施例２の絶縁層を得た。この実施例２における絶縁層において、その熱伝導率は３．２Ｗ／ｍＫであり、又、３９８Ｋにおける引張り貯蔵弾性率は６５５ＭＰａであった。

【００４３】比較例

絶縁材料として非球状アルミナを８６重量％含有するビスフェノールＡ型エポキシ樹脂を用いた以外は、実施例１と同様にして、比較例に係る絶縁基板を得た。

【００４４】又、実施例１と同様にして比較例の絶縁層を得た。この比較例における絶縁層において、その熱伝導率は３．５Ｗ／ｍＫであり、又、３９８Ｋにおける引張り貯蔵弾性率は７０００ＭＰａであった。

【００４５】なお、３９８Ｋにおける引張り貯蔵弾性率は、動的粘弾性測定器（セイコー電子工業社製　ＤＭＳ６１００）を用い、測定周波数１０Ｈｚ，昇温速度1℃／分の条件下で測定した。

【００４６】又、熱伝導性率は、前記樹脂組成物で約２．０ｍｍ厚×φ５０ｍｍの絶縁層（ブロック）を作製し、熱伝導率測定装置（ホロメトリック社製　ＴＣＡ

２００ＬＴ－Ａ）を用いて測定した値である。

【００４７】次に、実施例１及び実施例２の高放熱性絶縁基板及び比較例の絶縁基板におけるチップ抵抗実装パッドを設けた金属回路板上に、チップサイズ５．０ｍｍ×２．５ｍｍ，３．２ｍｍ×２．５ｍｍ、２．１ｍｍ×２．５ｍｍのチップ抵抗をそれぞれ１０個づつＰｂ－Ｓｎ共晶ハンダを用い実装し、実施例１・２及び比較例の絶縁基板を用いたチップ抵抗実装基板をそれぞれ作成した。

【００４８】以下、前記各チップ抵抗実装基板の構造を図１に基づき更に詳しく説明する。図１は前記の実施例１・２又は比較例の絶縁基板を用いて形成されたチップ抵抗実装基板１の模式断面図であり、このチップ抵抗実装基板１は、前記各絶縁基板２と、この各絶縁基板２上にハンダ接合部３を介して接合、固定されたチップ抵抗４とからなり、前記各絶縁基板２はアルミ板５上に絶縁層６を介在させて積層、接着された金属箔（導体回路）７からなるものである。従って、この場合、前記チップ抵抗４は前記各絶縁基板２における金属箔（導体回路）７上にハンダ接合部３を介して接合、固定されている。

【００４９】前記各チップ抵抗実装基板を１サイクル－４０℃×３０分～＋１２５℃×３０分の気相条件下で所定回数のヒートショック試験を行ない、マイクロスコープにて、ハンダ接合部分のクラックの有無を観察した。その結果を表１に示す。

【００５０】

【表１】

	３９８Ｋにおける引張り貯蔵弾性率（ＭＰａ）	熱伝導率（Ｗ／ｍＫ）	ヒートショック試験後のハンダ接合部の観察結果	
			100サイクル	500サイクル
実施例１	３５０	３．９	異常なし	異常なし
実施例２	６５５	３．２	異常なし	異常なし
比較例	７０００	３．５	部分的なクラックあり	全点においてクラックあり

【００５１】なお付言するに、実施例１・２の高放熱性絶縁基板及び比較例の絶縁基板における３００Ｋにおけるヤング率と熱膨張係数との積は、実施例１では２．４×10^6Ｐａ／Ｋであり、実施例２では２．８×10^5Ｐａ／Ｋであり、比較例では２．３×10^5Ｐａ／Ｋであり、これにより熱伝導率が３．０Ｗ／ｍＫ以上の絶縁層を用いた場合にあっては、ヤング率と熱膨張係数との積を２×10^2以上２×10^6Ｐａ／Ｋ以下にコントロールしても、表１との結果から、耐ハンダクラック性と相関性がないことが確認された。

【００５２】

【発明の効果】本発明においては、金属板上に絶縁層を積層し、該絶縁層上に導体回路を設けてなる金属ベース基板において、前記絶縁層は、３．０Ｗ／ｍＫ以上の熱伝導率を有する高放熱性絶縁層であり、しかも前記絶縁層の３９８Ｋにおける引張り貯蔵弾性率が１０００ＭＰａ以下に構成されていることにより、温度変化の著しい条件下でもハンダクラック性が発生し難い高信頼性のある基板を得ることができる上、高放熱性の基板となり得るのである。

【００５３】即ち、金属板上に絶縁層を積層し、該絶縁層上に導体回路を設けてなる金属ベース基板において、前記絶縁層が３．０Ｗ／ｍＫ以上の熱伝導率を有する高放熱性絶縁層であり、しかも前記絶縁層の３９８Ｋにおける引張り貯蔵弾性率を１０００ＭＰａ以下とすることにより、高放熱性を保持しながら、ハンダクラックの発生率が極めて小さくなるなどの効果を発現するのである。

【００５４】又、本発明に係る高放熱性絶縁基板においては、金属ベース基板において、絶縁層が３．０Ｗ／ｍＫ以上の熱伝導率を有する高放熱性絶縁層である場合にあっては、単純にはヤング率と熱膨張率の積を小さくすることができないといった問題をも好適に解消することができるなどの効果も奏するのである。

【００５５】更に、本発明のモジュールは、前記本発明の高放熱性絶縁基板を用いてなるものであり、激しい温度変化の繰り返しを受けても、電子部品を接合・固定しているハンダ部分やその近傍に亀裂や欠損等のクラックが発生することを防止することができるのであり、その結果、電気的信頼性が著しく高くなるなどの効果を発現するのである。

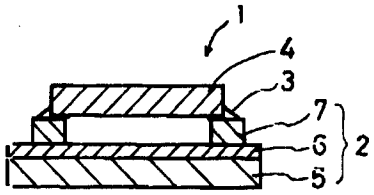
【図面の簡単な説明】

【図１】図１は、各実施例又は比較例の絶縁基板を用いて形成したチップ抵抗実装基板を示す模式断面図である。

【符号の説明】

１　チップ抵抗実装基板
２　絶縁基板
３　ハンダ接合部
４　チップ抵抗
５　アルミ板
６　絶縁層
７　金属箔（導体回路）

【図1】



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